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U. S. DEPARTMENT OF AGRICULTURE.  
BUREAU OF ANIMAL INDUSTRY.

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REPORT

OF THE

U. S. BOARD OF INQUIRY

CONCERNING

EPIZOOTIC DISEASES AMONG SWINE

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PUBLISHED BY AUTHORITY  
OF THE  
SECRETARY OF AGRICULTURE.

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## LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF ANIMAL INDUSTRY,  
*Washington, D. C., August 2, 1889.*

SIR: I have the honor to submit herewith the report of the Board of Inquiry appointed in December, 1888, to investigate certain contested questions relating to the epizootic diseases of swine. This report sufficiently indicates the nature of these questions, and consequently no further explanation is needed in this letter. I would simply add a word as to the available methods of prevention, since the report itself, although perfectly correct in its statements, is liable to leave a misapprehension in the mind of the reader as to the work and policy of the Bureau of Animal Industry.

The earliest and most extensive series of experiments made after the discovery of the germ of hog cholera, to determine the efficacy of inoculation as a preventive measure, were conducted at the Experiment Station of this Bureau. These experiments, I believe, indicate with greater certainty what may be expected from preventive inoculation than do any other experiments which have been made up to this time. Inoculation, however, was found unsatisfactory; first, because of the danger of spreading the contagion; and secondly, because the degree of immunity produced was not deemed sufficient to counterbalance the expense and disadvantages of the method.

The fact that the chemical products developed during the multiplication of the germs of hog cholera would create an immunity was first demonstrated by the experiments of this Bureau; and all that is known of this subject was brought out by these investigations. I have recognized the fact from the time I began the study of swine diseases in the interest of this Department that this was one of the most promising lines of research; at the same time it is one of the most difficult questions to investigate that is now before the scientific world, and the reason our experiments have not been carried further is that we have not had the laboratory facilities for this kind of work.

While we recognize the fact that disinfection can not be depended upon to prevent hog cholera without some change in the method of handling hogs, particularly in the West, we feel quite certain from our

experiments that it may be avoided, if, when the disease appears in a locality, the hogs are put in pens or small lots, where disinfection can be thoroughly carried out.

The problem of discovering a practical and efficient means of preventing hog cholera has been a most intricate and difficult one, but it is well worth the most thorough study, because the conclusions which are reached will doubtless apply more or less directly to all the contagious fevers of men and animals.

D. E. SALMON,  
*Chief of the Bureau of Animal Industry.*

Hon. J. M. RUSK,  
*Secretary of Agriculture.*



# REPORT OF THE UNITED STATES BOARD OF INQUIRY CONCERNING EPIDEMIC DISEASES AMONG SWINE.

Hon. J. M. RUSK,  
*Secretary of Agriculture:*

SIR: The above-named Commission received appointment from the Department of Agriculture during the month of December last, and their formal notification thereof was accompanied by a letter of instructions similar to the following:

U. S. DEPARTMENT OF AGRICULTURE,  
COMMISSIONER'S OFFICE,  
*Washington, D. C., November 27, 1888.*

SIR: I inclose with this an appointment for you as a member of a Board of Inquiry, the other two members of which are Prof. William H. Welch, of Johns Hopkins University, and Prof. T. J. Burrill, of the University of Illinois. The Board will convene at the Department of Agriculture, Washington, D. C., on December 12, and decide upon the plan of investigation and the methods to be employed. The details of this investigation will be left to the Board, without instructions or interference on the part of the Department, but all the facilities of the Department will be placed at its disposal.

I desire that the investigations of the Board will determine the following points:

(1) If the diseases of swine investigated by the Bureau of Animal Industry were properly described in the reports for 1885, 1886, and 1887, and if they were caused by the germs mentioned in connection with them, and if these germs were properly described.

(2) To what extent were these descriptions of the germs original, and to what extent had they been antedated by other correct descriptions and by investigations which would *demonstrate* their etiological relation to the diseases of swine, and particularly to the diseases as they exist in the United States.

(3) Is the disease which has been investigated by Drs. Billings and Roberts, in Nebraska, identical with one of the diseases described by the Bureau of Animal Industry, or is it different from both of them? Are their descriptions of the disease and the germ correct? Do their investigations show that the conclusions as given in the Bureau report are incorrect? Have any facts been established in regard to the swine diseases of this country by these investigations which differ materially from the conclusions given in the reports of the Bureau of Animal Industry?

(4) To what extent is Dr. Detmers justified in his assertion that "Dr. Salmon's *Bacterium Suis*, discovered by him in 1885, as a substitute for his *micrococcus*, has nothing whatever to do with swine plague. It is a septic germ, readily kills rabbits (*cf.* Bulletin of the Ohio Agricultural Experiment Station), and causes septicæmia, but has no connection with the disease in question?" Has Dr. Detmers published the details of any investigations which demonstrate the etiological connection of any microbe with an infectious disease? If so, does the microbe he has discovered differ

specifically from both of those described in the Reports of the Bureau of Animal Industry?

Please make such suggestions as may occur to you in the course of your investigations in regard to the proper method of treating and preventing these diseases. The report of the Board should be submitted to me on or before April 1, 1889.

Very respectfully,

NORMAN J. COLMAN,  
*Commissioner of Agriculture.*

Dr. E. O. SHAKESPEARE,  
1336 Spruce street, Philadelphia, Pa.

(NOTE.—Professor Welch declined, and Prof. B. Meade Bolton, of the University of South Carolina, was appointed in his stead.)

Modifications of the letter of instructions were made with one member of the Commission, viz., Professor Burrill, before his acceptance of his appointment; but as these were not made with the other members, they are not here inserted.

In fulfillment of the object of their commission, as explained by the accompanying instructions, the Commissioners met at Washington during the week of last Christmas and organized by the election of Dr. Shakespeare as chairman, and Prof. B. Meade Bolton as secretary. They sketched out a plan of work as follows:

(1) Examine methods of observation and research pursued in the Bureau of Animal Industry at Washington.

(2) Examine diseased hogs furnished by the Bureau of Animal Industry, making special endeavor to find the two diseases described by the Bureau authorities and the two germs claimed by them to be the cause of the respective maladies.

(3) Visit South Carolina for the purpose of examining into the nature and cause of epidemic diseases among hogs, prevalent there.

(4) Visit Nebraska for the purpose of examining the methods of Dr. Billings and the disease upon which he was at work.

(5) Examine into nature and cause of disease among hogs in various localities in that State.

(6) Visit as many outbreaks of swine disease in different parts of the country as possible with a view of finding if such existed—the two diseases and the two germs described by the Bureau authorities.

(7) Visit Dr. Detmers to examine his claims of priority and his methods of investigation.

(8) Examine separately and individually the morphological and pathogenic qualities of the germs found in the various localities where the Commission might find epidemics prevalent among hogs.

(9) Examine the question of immunity after a natural attack and after artificial inoculation from the stand-point of experience in Nebraska.

(10) Test especially the question of artificial immunity by experimentation at Philadelphia upon inoculated and recovered pigs obtained in Nebraska, as compared with controls.



After a session in Washington of several days, during which the first and second objects above mentioned were carried out, the Commission proceeded to Columbia, S. C., where they arrived January 1, 1889. They found and examined two outbreaks in the immediate vicinity of Columbia, and one other some 80 miles distant therefrom, viz., near the village of Florence, in the same State. The disease found in that State presented the clinical features and anatomical lesions, as well as germs, of "hog cholera," the latter, however, associated with some other microbes.

The Commission next proceeded to Lincoln, Nebr., and were cordially received by Dr. Billings, who rendered every facility for the prosecution of their inquiries. His methods were examined, and some five or six hogs which had been previously inoculated by him were studied *post mortem* and bacteriologically. The lesions found were in the main corresponding to "hog cholera," as previously described by him under the name of "swine plague," and also noted by the authorities of the Bureau of Animal Industry as "hog cholera." Specimens were also obtained from a natural outbreak located some nine miles away, with lesions and germs apparently identical with those of the inoculated pigs at the Agricultural Station. One of our number also visited Surprise, in the same State, and inquired into the history of the preventive inoculations there, as well as obtained two or three autopsies of pigs naturally affected with the disease; anatomical specimens and cultures were made on the spot and brought to Lincoln for study.

Arrangements were made for the purchase and shipment to Philadelphia of a number of Nebraska pigs, viz: Four pigs recovered from a natural attack of prevalent disease; five pigs survivors of preventive inoculation performed at Gibbon; five pigs survivors of the preventive inoculation performed at Surprise; and four pigs from the Agricultural Station at Lincoln, two of which, as stated by Dr. Billings, had been inoculated during the last summer with sterilized hog cholera cultures and subsequently exposed to the natural contagion without showing any sign of the disease; besides two others, survivors of an inoculation of nineteen pigs at the Agricultural Station, nearly all of which had subsequently succumbed to the artificial disease.

On their way homeward two of the Commission examined an outbreak of epidemic diseases among hogs near Lexington, Ky., and the member resident in Illinois subsequently found and examined an outbreak within that State.

After the Commission returned to their respective homes in the latter part of January, it was found necessary that the chairman should again visit Lincoln in the latter part of February in order to expedite the shipment to Philadelphia of the above-named experimental Nebraska pigs, and, finding it convenient, on his way homeward, he called a meeting of the Commission at Columbus, Ohio, to visit Dr. Detmers in response to his invitation and learn of his methods and work upon swine diseases.



Towards the latter part of February the eighteen Nebraska pigs reached Philadelphia in fair condition, and were, through the courtesy of Dr. R. S. Huidekoper, dean of the veterinary department of the University of Pennsylvania, placed on the grounds of that institution, where they were kept for experimentation, together with a number of control pigs purchased in the neighborhood of Philadelphia by the chairman of the Commission, as determined upon by the Board. Subcutaneous inoculations and feeding experiments were at once begun with virus obtained from Nebraska, Washington, Kentucky, and Illinois. The Commission again convened at Philadelphia the last week in March in order to confer concerning a report required by the 1st of April, as per letter of instruction, and found themselves unable at the time to formulate definite conclusions. The chairman reported this state of indefiniteness and requested the Secretary of Agriculture for extension of time. This request was granted, two months longer being allowed.

The Commission then dispersed again to continue independent researches at their own homes during the two additional months allowed, but about the 20th of April a letter from the Secretary of Agriculture was received by each commissioner, instructing them that owing to exhaustion of appropriated funds, cessation of investigations at the end of the first extra month was necessitated.

The commissioners were consequently obliged to terminate their investigations before reaching conclusions which were entirely satisfactory to themselves. Looking on their letter of appointment with accompanying instructions as a direction, not only to examine the respective opinions and claims of Drs. Salmon, Billings, and Detmers, but more especially to conduct a searching study by original and entirely independent investigations of the nature, cause, and means of prevention of the swine plagues of this country, the Commission cannot but regret the necessity of terminating their work and reporting that they themselves feel that they had proceeded sufficiently far in their independent labors to satisfy the reasonable expectations of the scientists on the one hand and of the swine-breeders on the other. Whether the germs with which Dr. Salmon has been experimenting are genuine and are the real causes of the respective diseases for which they are claimed to be pathogenic or not; or whether the microbe with which Dr. Billings is working is or is not the sole and only peccant agent; or whether Dr. Detmers was the original discoverer of the real germ, are all questions of great interest from the scientific stand-point; but the only question, in the opinion of the Commission, in which the farmers of this country, who suffer annually the loss of \$20,000,000 by these devastating swine plagues, are vitally interested, is, "How can these enormous losses be prevented?"

It will be seen that we venture to offer no definite conclusions concerning this exceedingly grave question. It is a problem into which so many factors enter, and for the complete solution of which so many



prolonged experiments upon pigs are required, that the time at our disposal has been entirely inadequate; and yet it was chiefly the hope of making some substantial contribution towards the solution of this very serious matter that induced the undersigned to accept at great personal inconvenience the appointment tendered them.

After the 1st of May the commissioners continued their work, but without pay, desirous of obtaining additional facts before reporting.

The Commission report only the results and definite conclusions deduced from the observations which they have been severally and collectively able to make. Conforming more or less closely to the order of the questions set forth in the letter of instructions above mentioned, they are as follows:

#### CONCLUSIONS.

(1) It is the opinion of the Commission, based upon their own individual observations and examinations of the subject, that there are at least two wide-spread epidemic diseases of hogs in this country which are caused by different micro-organisms, but which have clinical history and pathological lesions more or less similar, and very difficult to distinguish without the aid of a microscope and resort to bacteriological methods; and that these two epidemic diseases have been fairly well described in the recent annual reports of the Bureau of Animal Industry, except it does not appear that "hog cholera" of these reports can be said to have its special and exclusive seat in the digestive tract of the animal as distinct from the lungs. So far as the knowledge and observation of the Commission go, one of these epidemic diseases, viz., that called by the Bureau authorities "swine plague," appears to be far less prevalent than the other, which has been named by them "hog cholera."

The Commission are further of the opinion that the disease called by the authorities at Washington "hog cholera" is caused by the specific action of a certain microbe named by them "the hog-cholera germ," which has certain characteristics of form, size, movement, mode of growth in artificial cultures, and action upon certain lower animals, and taken together enable one to distinguish it from other microbes which have been described from time to time by various authors as present in swine disease; and that the descriptions of this microbe and its peculiarities, as set forth in recent annual reports of the Bureau of Animal Industry, are fairly accurate.

The Commission are also of the opinion, although to a less positive degree, that the epidemic disease called by the Bureau authorities "swine plague" has as its specific cause a certain microbe possessing characteristics which have been fairly well described in recent annual reports of the Bureau of Animal Industry, which distinguish it both biologically and pathologically from the first-mentioned "germ of hog cholera."

(2) It is the opinion of the Commission that the actual and unde-



niable proof of the pathogenic relations between the so-called "hog-cholera" germ above mentioned and the disease of hog cholera was first published in the annual report of the Department of Agriculture for 1885, and in the second annual report of the Bureau of Animal Industry of the same year, hence was not antedated with respect to epidemic diseases of swine existing in the United States. The discovery of the disease called "swine plague," and of the microbe to which it is due, must be considered original on the part of the Bureau authorities, at least as far as work in the United States is concerned.

(3.) In the opinion of the Commission the epidemic disease of swine investigated by Drs. Billings and Roberts, in Nebraska, however seemingly different in the published descriptions, is identical in its clinical features, pathological lesions, and specific cause with the disease investigated by the Bureau of Animal Industry at Washington, and called by the latter "hog-cholera"; and, furthermore, that the pathogenic microbe which is the specific cause of this disease is identical in both instances. It is also their opinion that the descriptions of this germ published by each of these investigators are in the main correct. The two chief points in these descriptions upon which the above-mentioned investigators have differed more or less widely are as to some minor points of morphology and variations of the behavior of the microbe under various methods of staining.

(4.) It is the opinion of the Commission that the microbe that Dr. Detmers at present regards as the specific cause of "hog cholera" is probably the same microbe which is considered by the Bureau authorities as the specific cause of hog cholera; but, according to present requirements of bacterial research and interpretation, it is impossible to declare that the organism as described by him in his reports published by the Department of Agriculture was the same thing.

In their observation of the methods of bacteriological research pursued by the Bureau of Animal Industry at Washington the Commission are of the opinion that as to carefulness and precision they are up to the standard of modern requirements concerning bacteriological investigations. They are essentially the same as those pursued at Berlin in the pathological laboratory of the Imperial Board of Health, and in the Hygienic Institute, of which Professor Koch is the head.

From their observation of the methods of bacteriological research pursued by Dr. Billings in Nebraska, the Commission are of the opinion that it was difficult, if not impossible, for that distinguished investigator by his usual method to discover and isolate a germ associated with "the hog-cholera germ" in the tissues of the body of the pig, and this is particularly true of the so-called "swine-plague" germ, claimed by the Bureau authorities to be the specific cause of the epidemic disease latterly named by them "swine plague." In the opinion of the Commission, therefore, the failure of Dr. Billings in his researches to find the so-called "swine-plague" germ in the tissues of the spleen



(the organ from which he almost invariably made his cultures) can not be regarded as incontestible proof that the "swine-plague" germ has had no existence in the afflicted hogs which have fallen under his observation, and affords no evidence that this last-named disease does not occur in Nebraska.

The Commission regard their experiments concerning immunity as inconclusive and more or less indefinite; yet it seems to be evident that there is a certain degree of protection against artificial acquisition of hog cholera possessed by the Nebraska pigs, which had been inoculated and which had recovered from the natural disease, the latter appearing to be slightly less protected than the former. Furthermore, the feeding experiments above mentioned appear to indicate that the hog can be artificially protected against the action of virulent living cultures even to a greater degree by introducing the germs into the stomach than by subcutaneous inoculation.

It is the opinion of the Commission that the only proper way to test practically the real value of artificial protection against "hog cholera" is to expose the supposed protected pig to the natural acquisition of the disease under ordinary conditions, such as exist among a herd of hogs suffering from the natural disease. It is a well known fact, brought to light by recent investigations concerning the nature of infectious diseases, that immunity or protection from a second attack, whether artificial or natural, is not absolute, but only relative in degree. There is no known infectious disease either of man or beast capable of producing by one attack a degree of protection which is surely and absolutely effective against a second attack.

Experience has abundantly shown that animals that are naturally or artificially protected can be practically overwhelmed by enormous doses of the germs of the disease, and thus be made to suffer a recurrent attack, which may even be fatal. Furthermore, the method of artificial inoculation and the mode of natural acquisition of the disease also seem to materially influence the degree of protection acquired. For example, it is well known that Pasteur has put into extensive practical application in France his method of producing artificial immunity against anthrax in sheep and cattle by subcutaneous inoculation; and it is also well known that the losses by this disease among herds where the inoculation has thus been performed have been reduced 90 per cent. as the result of inoculation; yet Koch, as an opponent of Pasteur, concerning the practical value of protective inoculation, has demonstrated beyond cavil that cattle in which subcutaneous inoculation has been practiced are but little protected against the acquisition of the disease experimentally by way of the digestive apparatus.

It is the opinion of the Commission that disinfection as a general practical means of preventing the enormous annual losses from diseases

of swine in this country can not be made effective under the conditions which exist in the West and other regions where hog-raising is extensive.

As far as our present knowledge extends, treatment of existing cases is utterly futile. There remain, therefore, to be considered but two alternative means of prevention—quarantine and extermination of infected hogs with their surroundings, or, on the other hand, some form of preventive inoculation.

The vast importance of the subject calls for an exhaustive investigation as early as possible of this latter means, for the former is very difficult of application.

Some of the tests made in Nebraska under the direction of Dr. Billings certainly give promise of great possibilities in this direction. It is the opinion of the Commission, however, that an attempt to produce immunity from “hog cholera” artificially by the use of the living germs of the disease, either through the stomach or through hypodermic inoculation, is very objectionable and involves a serious risk of more widely extending the disease and increasing rather than diminishing the already enormous losses therefrom; for every hog thus treated becomes for a time at least a center of infection from which an epidemic may directly or indirectly spread widely. Furthermore, the use of the living germs seems, at least in many instances, to permanently stunt the growth of the pig. Experience acquired in recent years shows that the chemical products of certain disease-producing germs in artificial cultures possess the same power to create immunity as do the living germs themselves; and some incomplete experiments performed by ourselves and others seem to strongly indicate that the chemical products of the “hog cholera” germ in artificial cultures also possess a similar power.

If further investigations shall prove this to be an indisputable fact, then, in our opinion, a safe, harmless, efficient, and extremely practical means of preventing “hog cholera,” free from any risk of thereby extending the disease and continuing the enormous losses at present suffered by our countrymen, will soon follow.

We have reason to believe that the threshold of such an important discovery has already been crossed; and we therefore earnestly advise that thorough and exhaustive investigation be as rapidly as possible made in this direction and without stint of money or hampering limitations of time.

The undersigned regret that the departure of one of their number for Europe before the draughting of this report has made it impossible for the entire Commission to sign it.

Respectfully submitted.

E. O. SHAKESPEARE, *Chairman.*

T. J. BURRILL.

WASHINGTON, D. C., August 1, 1889.



## REPORT OF PROF. B. MEADE BOLTON.

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Hon. JEREMIAH M. RUSK,  
*Secretary of Agriculture:*

SIR: I have the honor of submitting the following report as a member of the United States Board of Inquiry concerning epizootic diseases of swine. I regret having to report independently of my colleagues, but am compelled to do so, as I shall not have time in the near future to continue my investigations, and I believe that the conclusions I have been able to reach do not differ essentially from those of the other members of the Commission.

Before receiving my appointment on the Commission, I had already started investigations of epizootic diseases of swine in South Carolina on behalf of the South Carolina Agricultural Experiment Station, in conjunction with Dr. W. B. Niles, veterinarian to the experiment station, State veterinarian, and professor of veterinary science in the University of South Carolina, and I am indebted to Dr. Niles for valuable assistance in the whole course of my investigations.

The letter of appointment from the Hon. Norman J. Colman, late Secretary of Agriculture, is doubtless before you, and I have thought the most satisfactory way in which to attempt the solution of the problems therein stated would be to make investigations independently of any previous work of others. To this end I have visited, in company with my colleagues of the Commission, or with Dr. Niles, various portions of this and other States, examining diseased animals wherever opportunity offered, and collecting material for further investigations. But I also visited with the other members of the Commission the various laboratories where the disease in question had been studied.

The results of our investigations on behalf of the Experiment Station will soon appear in the form of a bulletin, and will contain substantially what I here have to report.

(1) During my work as commissioner I have failed to meet with an epizootic which I am satisfied was what is termed "swine plague" in the Bureau reports, though previous to my appointment on the Board I studied one such outbreak. In this case, however, I directed my attention to the bacteriological questions exclusively, and I am therefore unable to pronounce on the difference in the pathological lesions in the two

diseases. But I am not inclined to attach any great importance to these differences as set forth in the reports. The descriptions otherwise I find correct and well stated. In my investigations as commissioner I have been able to find but one organism which, in my opinion, caused the outbreaks under examination, and that I regard as identical with the hog-cholera germ described in the reports of the Bureau, and I find the description therein given correct. As will be inferred from what has gone before, I feel sure that another organism, correctly described in the reports as the "swine-plague germ," is found under circumstances which render it highly probable, if not certain, that it also causes disease.

As to whether these two organisms are always present and operate together to cause disease, or whether the two are merely varieties of the same germ, must be decided by future investigation. The differences between them, as pointed out by the Bureau, are sufficient to compel us to treat them as different germs, however perplexing it may seem that two micro-organisms are capable of producing such similar or, it may be, identical lesions.

By subcutaneous inoculations of the germ which I obtained from Nebraska, South Carolina, Washington, and Baltimore I failed to produce the disease by subcutaneous inoculations of even 5 cubic centimeters of bouillon cultures and more in hogs. I have, however, succeeded in producing it, though not every time, by feeding fasting animals (hogs) with bouillon culture.

(2) I have not been able to find that the descriptions of the germs contained in the above-mentioned reports from the Bureau have been antedated by other correct descriptions. Indeed, the bacteriological methods previous to the appearance of these reports were not nearly as accurate as those described in the latter, and consequently the value of the earlier observations is proportionally less. It is only by the correct application of Koch's methods that trustworthy results can be obtained, and it does not appear that these methods are employed in any investigations previous to the Bureau reports.

(3) The disease which has been investigated by Drs. Billings and Roberts in Nebraska I take to be identical with the hog cholera described by the Bureau. In the cultures I obtained from material in Nebraska I only found hog cholera as described in the Bureau reports, and the description of the organisms of the above-named gentlemen tallies more nearly with the description of hog cholera than with the description of swine plague contained in the reports of the Bureau. I do not see that any important facts have been established by any one which differ materially from the conclusions given in the reports of the Bureau of Animal Industry. The answers to the other questions in this paragraph are implied in what has already been said.

(4) My opinion in regard to the bacterism of swine plague as described in the reports I have already given under paragraph 1. What was re-



garded as proof of the etiological connection between a micro-organism and disease at the time when Dr. Detmers made his observations are no longer considered sufficient. I believe that Dr. Detmers would readily acknowledge that we can only be sure in such cases when we can isolate the organism and reproduce the disease with the organism so isolated, and it is not to his discredit that he was unable with the methods then employed to do this.

In our report to the Agricultural Experiment Station we say that we regard treatment of individual cases as useless or worse than useless. In regard to the prevention of the spread of the disease I can only recommend the measures as advised in the report of the Bureau.

There are still many interesting problems in regard to the epizootic diseases of swine which would reward investigation, but I have no doubt that they will all be solved in time by the Bureau without any aid from outside.

I was unable to visit Kentucky, where my colleagues studied an outbreak.

Very respectfully,

B. MEADE BOLTON.

UNIVERSITY OF SOUTH CAROLINA,  
*Columbia, S. C., May, 1889.*





